Non-Residential Capital Stock in Latin America. 1875 – 2008

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Abstract

This work offers non-residential capital stock estimation for major Latin American economies – Argentina, Brazil, Chile and Mexico - made towards a homogeneous method. This work covers the whole twentieth century and the years of the XXI century, expanding backward half century the present available estimations. Our research has the virtue of creating a capital stock method that could be applied to almost all Latin American economies, using the gross fixed capital formation data base (1850–1950) elaborated by one of the authors. This data could be linked with the investment series of standardized National Accounts of the Region, by ECLAC (Economic Commission for Latin America and the Caribbean). Also, the authors have done a comparison between Latin American countries and most advanced economies, especially on the comparative performance of two *settlers countries*, Argentina and Australia.

JEL Categories: N16;E22; E01

Keywords: Capital Stock, Latin America, Gross fixed capital formation, National Accounts.

1 Introduction

Since the beginning of economic theory, physical capital accumulation has been considered a key factor in economic development. However, capital stock measurement has not been included in the System of National Accounts (SNA). As a result, the stock of long-term capital is an economic aggregate which has been estimated by economic historians.

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The study of the capital stock in the developed world has been a recurrent research topic. The seminal works of Goldsmith[1], Kuznets[2] and Feinstein[3] have provided a reference for subsequent studies conducted on many industrialized countries. In the case of Latin America, estimates of capital stock have covered shorter periods and had less geographical scope. The most ambitious by Hofman[4], covers six countries for the period from 1950. For the period prior to this date, there is not yet a widely accepted estimate. The main purpose of this article is to fill that gap, and at the same time, get new answers about the relative backwardness of Latin America through the study of its capital stock. The core of the new evidence will consist of quantitative elaborations on the stock of productive capital.[5] (equipment and non-residential construction) during the long twentieth century (1875-2008) in four major economies in the region (AL-4) Argentina, Brazil, Chile and Mexico. These elaborations are contrasted with other similar developed countries, generating long-term visions of productive capital accumulation among advanced economies and developing economies such as Latin American. The aim of this article is primarily quantitative, and the aim is for it to be the first in a series of studies focusing on capital stock in Latin America, with the intention of building the databases necessary to make a methodical analysis of the causes of the relative backwardness of the region. Also, with this empirical basis, it will be possible to ascertain the investment strategies in the region, and how these might be related to the slowdown in growth rates, especially in the aftermath of the Great Depression of 1929-1933.

This paper is structured as follows. Following this introduction the next section describes the methods used to develop the annual series of non-residential capital stock. In the third section there is a validation of the results, comparing them with those obtained by previous authors in the study of the subject. The contrast is limited to investment flows in the period 1900-1950, since there are no previous elaborations before 1900. The fourth section is devoted to an analysis of our series, focusing on the growth rates of significant historical periods, in which special attention is paid to the evolution of the stock of machinery and other equipment. In the fifth section the process of capital accumulation in the four Latin American economies is compared capital accumulation in a sample of advanced economies. The article ends with a section of concluding remarks.[6]

2 Methodology for measurement capital stock in Latin America.

The quantification of non-residential capital stock in Argentina, Brazil, Chile and Mexico presented here points towards a more comprehensive statistical reconstruction that ultimately could cover the whole Latin America.[7] This has two important methodological implications. The first is that we have used those sources and calculation methods consenting obtain-

[1] Goldsmith, "A Perpetual Inventory".

[2] Kuznets, *Capital in the American Economy*.

[3] Feinstein, *National income*; Feinstein, *Studies in capital formation*.

[4] Hofman, *The Economic development*.

[5] Given the enormous difficulties that we have encountered in calculating the housing capital stock, without falling into dangerous arbitrariness, we decided in this first stage of research stick to the stock of productive capital.

[6] The capital stock series (in index numbers) are available at: https://sites.google.com/site/cristianaducoingruiz/non-residential-capital-stock-in-latin-america-series. The series, denominated in a common currency (U.S. dollars 2000) refer to gross stock and the net stock, computed by a straight-line depreciation and mixed (geometrical-linear).

[7] The discussion about what Latin America meant is irrelevant. Independent territories are considered to be those Latin American countries south of the Rio Grande with language derived from Latin. Bulmer-Thomas, *The Economic History*, (p. 1)

ing training and series of capital stock minimally consistent for all Latin American nations.[8] Second, we applied homogeneous estimation procedures that ensure comparability of the resulting national series.[9]

This estimate is based, like the vast majority of studies of this type, on the perpetual inventory method (PIM). Any evaluation of the capital following the PIM approach arises from a historical series of investment flows. Therefore, it is essential to specify the procedures for calculating the gross fixed capital formation (GFCF). In this sense, the first thing we have to make clear is that our measurement of GFCF covers the period 1850-1950. We do also handle data for 1950-2008, in order to have the necessary statistical basis to know what the evolution of the capitalization process in the course of the twentieth century or rather the 'long twentieth centruy' has been. However, the series of GFCF concerning this second period were not designed by us have been used but those by Hofman[10], updated to 2008.[11] In the following lines we describe, first, measurement method used in GFCF, and then the process of developing the capital stock series.

The investment series concerning the period 1850-1950 are from the previous work done by Tafunell.[12] It will offer two series for each one of the Latin American countries, valued at 1950 prices, on investment in equipment and construction. The first one basically consists of a quantification of the value of imports of machinery and other capital goods, in current values for the period 1856-1929, and in real terms for the years 1929-1950, during that period based on the unit value in 1950 of imports of each type of asset (tariff heading). More precisely, the quantitative basis for the period 1856-1929 has been built on exports from Germany, United States and United Kingdom (hereafter, G3), the major suppliers of capital goods to Latin American economies. After deflating the series for the first period by a price index of machinery and transport equipment based 1913, we calculated a series of value of imports from each country, at 1950 prices, covering the years 1856-1950. Data for the years 1850-55 were estimated with a proxy to provide the magnitudes of investment since 1850.[13]Finally, the resulting series was added to the figure for the estimated value of domestic production of capital goods between 1900 and 1950. We judge that the resulting final series can be accepted without reservation as the available supply of capital goods in the four economies studied, assuming of course, the perfectly reasonable argument that domestic production was nonexistent, or statistically irrelevant, before 1900 and that there was no re–exports.[14]

The mentioned work by Tafunell[15] quantifies construction investment by measuring two basic inputs of the same: the apparent consumption of iron and steel for construction, on the one hand, and portland cement, on the other. Hence we obtain a series of volume, by the geometric mean (since 1900) of two sets of physical quantities (tons of iron and steel and cement). By 1925 the figure corresponding to iron-steel was made from G3 exports, except for

[8]Local statistics might be useful to contrast foreign statistical sources' reliability. In the case of Chile there are excellent statistical sources; see e.g. Ducoing, "*Inversión*" and Ducoing and Tafunell, "Formación bruta".

[9]Tafunell, "Capital formation in Latin America".

[10]Hofman, *The Economic development*.

[11]Hofman's figures on aggregate investment almost always coincide exactly with the online database on National Accounts compiled by ECLAC, in particular the series expressed in 2000 dollars, and they cover the same years (1950-2008). V. http://www.eclac.cl/deype/cuaderno37/esp/index.htm. Thus information was kindly supplied by André Hofman.

[12]Tafunell, "Capital formation in Latin America"; Tafunell, "Capital Formation in Machinery".

[13]In the case of Argentina and Chile, 1856 figure extrapolated using growth rates of British exports of machinery to these countries, according Llorca, *The British textile*; for Brazil extrapolation rely on the value of total imports Mitchell, *International historical*, pp. 432-3, , and for Mexico in government revenue Mitchell, *International historical*, p. 669,.

[14]On the domestic production of capital goods in Latin America, cf. Suzigan, "Estado e Industrialização"; Tafunell, "Capital Formation in Machinery"; Gómez-Galvarriato and J.G., "Was It Prices"; Ducoing, "*Inversión*".

[15]Tafunell, "Capital formation in Latin America".

Mexico, which also joined domestic production. Mexico was the only one of the four countries that manufactured steel products intended for construction before 1925.[16] Until 1900 the indicator index managed as construction investment adheres to imports (exports G3) iron and steel, plus artificial cement consumption.[17]

We cannot fail to note that the quantification of GFCF we used for the pre-1950 era has two limitations on the construction investment. The first is that it does not distinguish between residential and non-residential, which is a serious disadvantage when analyzing the interaction between the development of productive capital stock (non-residential) and economic growth. The second limitation is that the quantification suffers from an upward bias, the importance of which we are not able to weigh, because the iron, steel and cement building materials are 'modern'. Their use had been spreading steadily since the mid-nineteenth century, replacing traditional materials such as wood, stone, clay, etc..

The first of these constraints is not unique to the estimation where this work is based: the official Latin American National Accounts since 1950 are extremely restrictive in terms of disaggregation by category of goods, or destination investment. In a generalized way, the aggregate investment is only broken down into two basic categories: capital goods and construction. The existing series on residential and non-residential construction are the work of individual researchers. As noted above, we have chosen to give credence to the statistical reconstruction made by Hofman, which divided investment between residential and non-residential, applying uniform criteria for the countries studied, as far as the sources allowed. For the period prior to 1950 this means the index prepared by Tafunell quantum is, after all, reasonably representative of the non-residential construction (the case would be debatable if it had to be extended to residential).

The purpose of this paper is not to make an empirical contribution on capital formation, but on stock. Therefore, determining the current magnitude is, for us, purely instrumental. The GFCF series merely perform the function of input with which we construct the time series of capital stock.[18] However, we understand the importance of building the number of GFCF as critically as possible to avoid upward bias or underestimation of the capital stock. As indicated, like almost all previous work done on the accumulation of capital, we apply the MIP measurement system, which consists of the weighted sum of past investment flows. The gross stock investment is calculated by adding the cumulative year-to-assets and subtracting totally worn (withdrawals).

The formula for calculating the gross stock in year t is thus the following[19]

1.) $GFCS_{t-1} + GFCF_t - Rtr = GFCS_t$

Where $GFCS_{t-1}$ is the stock of year $t-1$, $GFCF_t$ is fixed capital formation in the current year (t) and Rtr are capital withdrawals produced in the current year. The net stock is obtained by subtracting the gross stock depreciation, which is expressed in mathematical terms as follows:

2.) $NFCS_{t-1} + GFCF_t - \delta - \delta(Rtr) = NFCS_t$

Where $NFCS_{t-1}$ is the net capital stock at the beginning of year t, $GFCF_t$ is the gross fixed capital formation during the year, δ is the depreciation during the period, $\delta(Rtr)$ are

[16] Tafunell, "Capital formation in Latin America".
[17] Tafunell, "On the Origins".
[18] For an analytical description of the long-term evolution of GFCF in Latin America cf. Tafunell, "Capital formation in Latin America".
[19] Feinstein, *Studies in capital formation*.

depreciated capital goods removed during the year t and $NFCS_t$ is the net capital stock at the end of period t.

The PIM requires two masses of information: historical series of GFCF at constant prices, for each type of asset and the capital stock in the initial year.[20] The latter can be derived directly from the first mass of information, when you set the initial year in the terminal year of life of the first generation of assets with the greatest longevity. For example, with respect to the nineteenth century, if we attribute a life of 50 years to non-residential buildings and we have investment series dating back to 1850, the initial year of the aggregate capital stock is 1900. This is precisely the option we have chosen. Upon calculation of the capital stock in equipment only the initial year of the stock goes back to 1875, on the assumption that, during that period, the life of these assets was 25 years (See table 1).

The PIM requires to set a life for each type of assets, as well as retirement and depreciation functions. As regards the average useful life of assets, as stated by Hofman[21], there is no empirical evidence on Latin American economies in the past. Given the lack of information, all the authors who have worked on the subject have tended to take the half-lives generally established for developed economies, that is, 50 years for buildings and 15 years for capital goods [22](see Table 1). We have followed this approach only for comparison with the more industrialized countries (see Section 5).[23] In line with recent studies, we argue that it is more realistic to expect that the lifetime of assets will shorten progressively over time as a result of the acceleration of technological change.[24] Table 1 contains the values that we have adopted[25], in accordance with the parameters set by others. It should be noted that the lifetime is the parameter that has the greatest influence in determining stock[26]

Regarding the retirement function, the most widely used measurement of productive capital in the OECD economies[27] is one of Winfrey distribution curves, reflecting the probability that an asset is removed within a specified period of years, taking as a benchmark the average lifetime. However, the authors who have made long-term capital stock measurements of economies of the region adopted a different retirement function, the so-called sudden death or retirement of each generation assets in the final year of their lifetime, for two reasons. The first reason is the lack of information. The second reason is the fact that implementation of any of the Winfrey functions requires more disaggregation of the investment series by asset, which represents a limitation for the current research. We have decided to be guided by the pattern commonly accepted which is sudden death (simultaneous withdrawal). But we should not ignore the fact that both the criteria and the alternative we are a mere approximation to reality.

The last parameter essential for the calculation for net capital stock is the depreciation or

[20]OECD, *Measuring Capital*.

[21]Hofman, *The Economic development*.

[22]According to Ward developing countries do not have the information necessary to determine either service life or survival functions.Ward, *The Measurement of capital* Argentina's recent experience fits the model for developed countries, but perhaps this is due to the adoption of a technological pattern suggested by Coremberg, "Midiendo las fuentes". There is a lot of uncertainty surrounding this issue, because among advanced economies there are striking differences in half-lives established for the same asset class, cf.Blades, *Service Lives*

[23]Since this comparative exercise is conducted setting our results against the development of Maddison we have adopted the assets' lives he applies. In particular, he argues for duration of 39 years for non-residential construction and 14 years for capital goods. Maddison, *Standardised Estimates*

[24]Blades already warned this problem in his seminal study. Blades, *Service Lives* Henríquez on Chile, and Prados & Roses, about Spain, have measured different lives by assets.Henríquez, *Stock de Capital*; Prados de La Escosura and Rosés, "Capital Accumulation"

[25]This values could be considered arbitrary, but doesn't exist any historical study about the life of the assets in Latin America.

[26]Dalgaard and Thomsen, "A Comparison"; Henríquez, *Stock de Capital*.

[27]OECD, *Measuring Capital*.

capital consumption, which results from wear and tear of active use because; unlike retirement, which depends on the decisions of the agents . The depreciation rate should reflect the efficiency of the good, which means that it decreases with increasing age. There are multiple depreciation functions: linear, geometric, geometric set, sum of digits, hyperbolic and bulb (or total depreciation in the last year). It is not clear which role most closely reflects reality, so there has been debate about whether to use the net capital or gross capital productivity measurements.[28] In any case, the most commonly used depreciation functions are linear and geometric. The former is described in the following formula

3.) $Dt = V$

Where V is the value of capital and t life years, 1,2, ... t. The feature of this function is that the asset is depreciated by the same amount each year, assuming a null value at end of period. For geometric depreciation, the formula is:

4.) $V_t = V_0[1 - (1/T)]^t$

This function is used in a majority of cases because admits that in the early years the assets are depreciated through relatively little use, while, on the contrary, when they reach an advanced age intensely productive capacity is impaired.

We performed three measurements of net capital stock, applying three different depreciation rates: linear, geometric and a combination of both. The first approach reflects the fact that some of the authors who have preceded us, especially Hofman, have chosen this role of depreciation, which, incidentally, is the method advocated by SNA SNA-1993.[29] As it is of great interest that we can compare our results with those of these authors, we applied the same method of calculation. Also for this reason we have chosen geometric depreciation. Finally, we put into play a third option, which we call "mixed depreciation." We judge that is closer to reality than the previous two. Indeed, it seems reasonable to assume, first, that the depreciation of the building tends to have a linear profile, while, on the other hand, the depreciation of machinery and other equipment is clearly a profile curve geometric efficiency.

3 Comparison with other estimates

Regarding the countries analyzed, the first study on the capital stock with a modern approach to concept was held at an early date. Nevertheless, the fact is that there is little empirical research on the non-residential capital allocation in the period before 1950. The work just alluded to is that of ECLAC.[30] It assesses the net capital stock between 1945 and 1952 (to be exact, since 1940, but data were not published 1940-5). ECLAC calculated capital stock not only with respect to the four economies that are the subject of our study, but also for the whole of Latin America.[31] Quantified capital corresponds to the building and productive equipment. The measurement was made using the PIM method, based on industrial and agricultural censuses of 1940 (or 1939) and 1950, combined with a series of gross and net capital, expressed at 1950 prices, employing the GDP deflator.

[28] O'Mahony, "Measures of capital".

[29] V. UN System of National Accounts 1993

[30] CEPAL, *Estudio económico*.

[31] See. Table 1, p. 9. The text suggests that "Latin America" is the addition of seven countries for which some information is available on the existing capital: Argentina, Brazil, Chile, Colombia, Cuba, Mexico and Venezuela. According to ECLAC, the aggregate should represent between 85 and 90 percent of capital in the region.

This initial calculation ECLAC[32] has been implicitly or explicitly amended by further elaborations of the institution, such as the 1956 and 1957 studies (ECLAC)[33] , and by other researchers, using different assumptions, as did Cossio & Izquierdo, for Mexico.[34] But in any case, such developments do not generally go back further than 1939. According to Goldsmith[35], data for Brazil reaches back as far as 1913 although by its nature, it is difficult to compare with our measurements.[36]

The picture is quite different for the period after 1950. This is mainly due to the contribution of Hofman.[37] With it we have series of gross and net stock of aggregate capital and non-residential capital at constant prices in national and international currency, six Latin American economies (the countries discussed here plus Colombia and Venezuela). These findings are extremely noteworthy given that the author has used a consistent method of estimation. It was precisely this, coupled with the consistency of quantification, which pushed us to link it with ours, i.e. to splice the respective series of investment flows in 1950.

Hofman himself thoroughly review and systematic assessments made previously on capital stock in these countries, which invariably start at around 1950, if not later.[38] We will not, therefore, duplicate what he has already written. But we must add that the work of André Hofman has encouraged other researchers to make new estimates of the domestic capital stock, provided since 1950. Considering the studies those providing authentic historical series, and therefore ignoring measurements that cover only the most recent years, it should be mentioned the following works.

In the case of Argentina, as mentioned by Hofman[39], there are older estimates of capital stock, based on the contribution of Bunge.[40] Another work for the period 1900 - 1960 is the estimation made by Balboa & Fracchia.[41]This radically changes when we look for new historical researches, where we can only mention the accomplishments of Maia & Nicholson[42] who, with the intention of making progress in estimating the total factor productivity of Argentina, they made a capital stock calculation, collecting GFCF data from several authors. The lack of recent historical estimates of capital stock in Argentina, is mainly due to the serious difficulties in standardizing prices during the two decades of hyperinflation, 1970-1990, which even led to a reassessment price of assets as capital goods up by 64%.[43]

Regarding Brazil, we have the elaborations of Marquetti[44], Morandi & Reis[45], Feu[46] and Morandi[47]. The estimations of Marquetti[48] are based largely on those of Hofman, and dif-

[32]The Spanish acronym for ECLAC is CEPAL

[33]CEPAL, *Análisis y proyecciones*; CEPAL, "El desequilibrio externo".

[34]Cossío and Izquierdo, "Estimación".

[35]Goldsmith, Contador, and Mello, *Brasil 1850-1984*.

[36]Goldsmith estimates the net capital stock (not unbundled) at current and constant prices, between 1913 and 1980 in four-year time-breaks (Table IV-5, p. 154). Its calculation is based on the previous estimate of one author (Langoni) on the stock in 1948, projecting it back until 1913 on the premise that the GFCF was 10 percent of GDP and NFCF remained the same proportion of GFCF in the period 1948-68. It must be emphasized that this estimation procedure, which Hofman describes as ingenious, is extremely tentative.Hofman, *The Economic development*

[37]Hofman, *The Economic development*.

[38]This comprehensive methodological note is in Appendix H (pp. 265-291).

[39]Hofman, *The Economic development*, p. 266-271.

[40]Bunge, *Riqueza y renta de*.

[41]Balboa and Fracchia, "Fixed Reproducible".

[42]Maia and Nicholson, *El Stock de capital*.

[43]Hofman, *The Economic development*, p. 184.

[44]Marquetti, "Estimativa do estoque".

[45]Morandi and Reis, "Estoque de capital".

[46]Feu, "Avaliação da Produtividade".

[47]Morandi, *Estoque e Produtividade*.

[48]Marquetti, "Estimativa do estoque".

ferentiate between investment in residential and non-residential construction in a similar way. They also assess investment in residential and non-residential construction for the pre-national accounts (before 1947). This assessment relies on a combination of four indices by the method of principal components. Meanwhile, Morandi & Reis[49] rely heavily, for the first half of the century, on data concerned with capital formation in the public sector. Feu[50], in fact, has not conducted an empirical contribution, since she uses the existing official data on which she performs a calculation of stock exercises than those used by previous authors. Morandi attempted to correct the bias regarding housing investment, which, according to this author, all previous computations suffer.[51]

Capital stock estimates are quite poor in Chile, in contrast to the data sources available in the country. No attempt has been made to estimate historical capital stock in the way that Hofman has done for other countries and we can only include the contributions of the Central Bank of Chile, through Henriquez[52], who despite only calculating the last years of the twentieth century, she uses GFCF data from 1900, as some of the infrastructure works have a 100 years survival profile (see table 1).

Finally, the dynamics of Mexico's capital stock has deserved a singular attention. It may qualify because, unlike other countries, the institutions responsible for national accounts have elaborated capital stock series. First was the Bank of Mexico, and, from 1984, the National Statistics Institute (INEGI) which performs a comprehensive assessment of the stock and sector, at current prices.[53] In any case, since the work of Hofman, only one has appeared that has provided long series, unbundled GFCF and capital stock, which is due to Mariña.[54] Actually, this author deviates very little from Hofman's findings.[55]

Given the above, it is abundantly clear that the comparative exercise we can perform is limited to capital formation in the first half of the twentieth century. The studies that have been conducted so far on the subject have quantified investment flows generated from 1900, in order to assess the magnitude of the stock since 1950. We, however, have determined the amount of the investment in the second half of the nineteenth century, and the first half of the twentieth century, in order to derive the capital stock in the years 1900-1950. For later dates, our sets are only marginally original stock, since, as we have indicated, we just take investment series developed by Hofman.

We use panel graphics (figure 1) to represent our series of investment in capital equipment and non-residential construction for the period 1900-1950, along with the series for previous estimates. The graphics represented in figure 1 do not throw up significant differences in terms of long-term trends. By contrast, conspicuous discrepancies are relatively large movements in short and medium term. In general, these discrepancies tend to be higher among the series of construction investment. In our measurement, cyclical fluctuations tend to have less breadth and intensity than suggested by other authors. In the case of capital goods, rather the opposite occurs, but it is obvious that the profile shape is separated or has divergent periods that do not match with classical statistical sources, either during the First World War or the period of the Great Depression.

[49]Morandi and Reis, "Estoque de capital".

[50]Feu, "Avaliação da Produtividade".

[51]Morandi, *Estoque e Produtividade*.

[52]Henríquez, *Stock de Capital*.

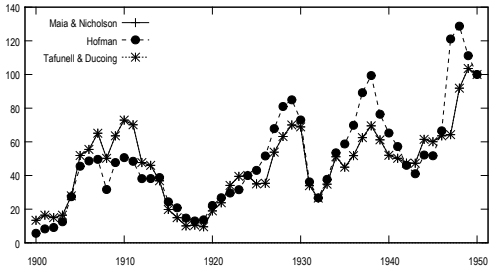
[53]The Bank of Mexico estimates have been severely criticized, cf. Loría and Jesús, "Los acervos". See Hofman, *The Economic development* and Mariña, "Formación y acervos" for a critical feature of these estimates.

[54]Mariña, "Formación y acervos".

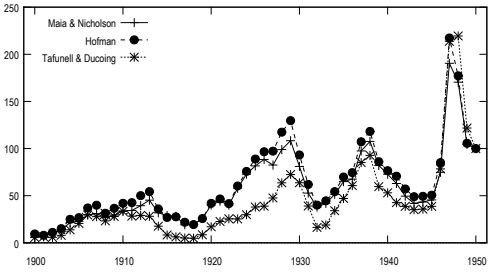
[55]In what seems, only differs from Hofman in making slightly different assumptions about rates (fixed) investment for the periods when there are no disaggregated data, as well as granting greater useful life residential construction and error correcting Hofman allegedly made to estimate the investment in non-residential construction since 1970.

Figure 1: Non Residential GFCF 1900 - 1950 by country. Several authors (1950 =100)

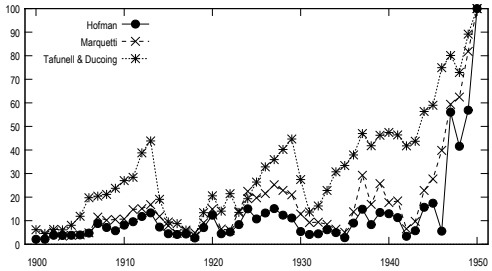
Argentina. Non Residential Construction



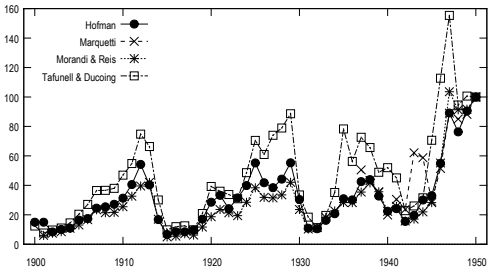
Argentina. Machinery and Equipment



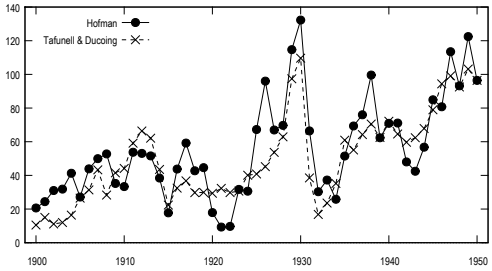
Brazil. Non Residential Construction



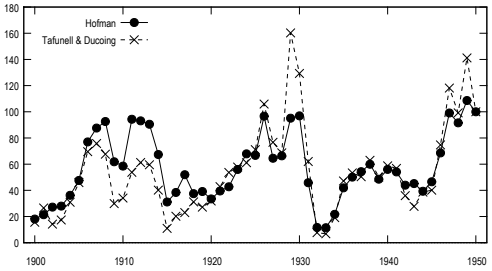
Brazil. Machinery and Equipment



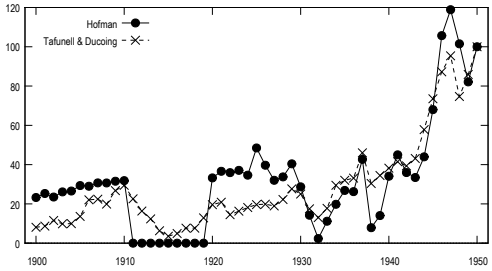
Chile. Non Residential Construction



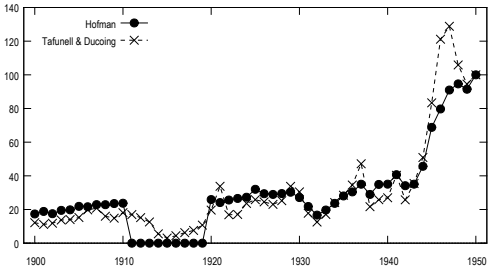
Chile. Machinery and Equipment



Mexico. Non Residential Construction



Mexico. Machinery and Equipment



Source: see section 3

4 Cycles and trends in the capitalization process

As is obvious, and has been observed in the previous section, capital accumulation has not followed a linear course in Latin American economies studied, as in any other. Table 2 shows the growth rates of the productive capital stock over the long twentieth century (1900-2008), distinguishing the four major historical periods that it divides into.[56] Looking at the data, the first comment to be made is methodological: the use of either method of depreciation of assets (linear, geometric, mixed) is quite indifferent, as the results derived are very similar.

Table 2

In a global balance of the century the figures in Table 2 show that the four countries are divided into two groups. On one side are Argentina and Chile, the two economies with a greater degree of economic development both in the late nineteenth century and early twenty-first century.[57]In the very long term, its capitalization has kept similar pace of growth. On the other hand we find Brazil and Mexico, the two largest economies of the region in the second half of the nineteenth century when were characterized by their low level of development. Table 2 shows that between the two there has been a noticeable difference in terms of the investment effort. Paradoxically, it was higher in Mexico than in Brazil, where the starting point of the first was higher than the second and the gap between them in term of GDP per capita has narrowed considerably over the course of the century.[58] In any case, Brazil and Mexico have increased more their productive capital than Argentina and Chile, which undoubtedly has contributed to get a partial convergence between the four economies.

Through historical eras that have shaped the twentieth century, the capital accumulation patterns have changed substantially.[59]In addition, the countries analyzed have not behaved in exactly the same way, although a common pattern has prevailed.[60] During the final period of the first globalization era (1900-1929), capital allocation increased significantly and to the same extent in the four republics.[61] But they did not react in the same way to the disintegration of the international economy (1930-1945), which had its translation in terms of capitalization. Chile won the poorer balance, due to brutal blow dealt by the Great Depression. In the opposite sense, Mexico, due to the public policies implemented by their governments did even better, on a net basis, in terms of the pace of progress in comparison to the first three decades of the twentieth century. The era of state-led industrialization (1946-1981) stands out above all others for the extraordinary advance in capital accumulation, with one notable exception, Chile. While the other three nations in growth rates are much higher than those recorded in any other era, Chile only managed to advance at a rate marginally higher than during the entire century. In Chile, 1980 saw the advent of the real golden age in the capitalization process and it has continued to the present. For all other countries, the collapse of the

[56]Growth rates have been calculated by fitting a log-linear straight to prevent them being too influenced by the choice of either initial and terminal periodization. Unless otherwise indicated in the tables below we have followed the same approach.

[57]By 1900, Argentina's GDP per capita was the highest in Latin America, while that of Chile stood in second position, along with that of Uruguay. In 2008, Chile lead the ranking of the region, with Argentina in second place.Bolt and Zanden, *The First Update*

[58]According to data compiled by Maddison, *Contours* and the update done by Bolt and Zanden, *The First Update*, in the year 1900, the per capita GDP of Mexico was twice than Brazil. In 2008 Brazil's per capita GDP exceeded the Mexican by only 24 percent.

[59]Cardenas, Ocampo, and Thorp, *An Economic History*.

[60]Yáñez and Carreras, *The Economies*.

[61]The almost complete overlap in the growth rates of gross capital stock is not repeated in those relating to net capital investment due to the slowdown in Argentina caused by World War I and in Mexico after the Revolution.

model state-led industrialization and its replacement by an open economy has paid off disappointingly with regard to the expansion of productive physical capital stock. In all of them the growth rates for the years 1982-2008 are clearly well below the average of the century (1900-2008). But that is pertinent to a qualification: there is huge distinction between the spectacular rate of between 6-7 percent in Chile and the modest 1 percent in Argentina. The ability to make the necessary economic reforms and adapt to the new international economic environment has been uneven, and this certainly is reflected in the figures of the last rows of the table mentioned. For example, while both Brazil and Mexico were shaken by severe currency and financial crises in 1980 and 1990, the growing integration of the Mexican economy in the U.S. economy is probably at the basis of the best Mexican investor performance.

The provision of machinery and other equipment deserves special attention, because in the long run, it seems to have more influence on economic growth than do other capital assets. In our estimation, capital stock in equipment has the additional virtue of their greater extension on time, providing additional empirical evidence that help us to get a better understanding of AL4 growth dynamics in the first economic globalization (1870 - 1914). Table 3 shows the results, following a more precise periodization before the Great Depression.

Table 3

Indeed, the picture now being drawn reveals a different reality in the periods preceding the 1929 crisis(see Table 2). Three aspects are remarkable. The first is that, until 1913, the equipment increased accumulation at high speed, higher than the average recorded in the 1875-2008 period. The second notable feature is the marked tendency to slowdown in the periods 1891-1913 and 1914-1929, compared with the earlier period of faster capital accumulation, 1875-1890. This can be attributed, in part, to the Gerschenkron effect: because of the very low starting point, in the initial stages of the growth process of industrializing economies tend to grow at very high rates. However, the slowdown that occurred in 1914-1929 could also be caused by reduced opportunities for Latin America to participate in the international economy as a result of World War I. The third aspect that should be emphasized is in varying degrees of dynamism of the four countries. Argentina stands out until 1913, and not later. The achievements of the Porfiriato[62], in this field, also seem quite impressive. The rupture of export-led growth model had a strong impact on the enlargement process of the production equipment. It is interesting to note that, when considering the net capital during the period 1930-1945 the stagnation of capital goods endowment was more intense than the one in the aggregate non-residential capital. Brazil, and especially Chile, suffered a regression. After World War II the previous pattern was restored: capital equipment tends to grow faster than the overall non-residential capital. The figures in Table 3 relating to the periods 1946-1981 and 1982-2008 do not require additional comments or explanations to those put on the table above.

5 The AL-4 capitalization in the mirror of the most advanced economies

Angus Maddison made serious attempts to calculate the levels of investment and capital stock, restricting them to a few advanced economies for which there are statistical sources. In Mad-

[62]The historical period knows as the *Porfiriato* were the years under when the Mexican Government was under the rule of Porfirio Díaz (1876-1910).

dison[63] historical series of productive capital accumulation (capital nonresidential) were published for six developed economies: Germany, France, UK, Japan, USA and the Netherlands. As in this article, the data are estimates are half-year, considering the accumulated investment as the expected life of the relevant assets. For Maddison these are all non-residential structures, machinery, vehicles and equipment, excluding land, natural resources, intangibles (human capital, etc.), precious metals, foreign exchange reserves, foreign assets, etc. In short, the asset class that counts as productive capital according to Maddison corresponds exactly to the one we have adopted here: capital goods and non-residential construction.

One of the main reasons for using Maddison's figures is because they are denominated in the same currency (Dollars Geary - Khamis) for the six countries, which offers more opportunities for valid patterns and drawing lessons for the study of Latin America. To this end, and for comparative purposes only, we have made for AL - 4, an alternative productive capital stock estimation using the same parameters as used by Maddison on the life of assets and their depreciation and retirement functions. We have also included Spain in this comparison, using a consistent method to see the patterns of the metropolis and its formerly colonies.[64] Table 4 shows the results.

Table 4

On balance, we can say that the experience of capital accumulation of large Latin American economies in the long term has not departed significantly from the path followed by the more developed economies. It is striking that the secular growth (1890-1991) of the leading nations (U.K. and U.S.) has been moderate, with rates of around 2.5 percent per year. Advanced economies, which industrialized later (Japan and Spain), increased their productive physical capital at a significantly higher rate. The trajectory of Latin American economies is located exactly in between one and the other. The most advanced economies in the region, Argentina and Chile, had a secular growth pattern similar to Anglo-Saxon countries, while Brazil and Mexico, because of its low starting point and strong economic growth, expanded their capital to a greater extent than Spain, although not as much as Japan.[65]

A cursory examination of the figures in Table 4 on the various historical periods discovers some revealing aspects, which, without any doubt, should be explored in greater depth in a subsequent study. One of them refers to the heyday of the first globalization (1890-1913). While capital accumulation progressed sluggishly in Europe-in its most modern areas (U.K.) and the backward (Spain) - in Japan and across America, from the U.S. to the Southern Cone, infrastructure and production equipment expanded vigorously. World War I disrupted this dynamic, especially in Latin America. There was a brutal downturn, much higher than that which occurred in Britain and the United States, not to mention Spain and Japan, where, however, capital endowment was intensified. The stagnation in Latin America could be interpreted as the meager dividends accrued to the economies of the subcontinent restoring an export model in the post-war context, linked possibly to the meager results achieved in the process of industrialization.

The years 1929-1950 were marked by the impact of the Great Depression and World War II. In addition to accelerating its growth, from that recorded in the years 1913-1929, it clearly surpassed even the most advanced countries, excluding Japan. No doubt, not participating actively in the war and starting the process of import substitution weighed decisively in this

[63] Maddison, *Standardised Estimates*.

[64] We have taken the series of capital formation flows in Spain from Prados de la Escosura, *El Progreso económico de España 1850-2000 [The Economic Progress of Spain 1850 - 2000]*

[65] Bértola and Ocampo, *The Economic Development*; Yáñez and Carreras, *The Economies*.

relative improvement. In the golden age (1950-1973), the model of state-led industrialization promoted in Latin American countries fueled the process of capitalization. In this sense, the data in Table 4 are perfectly consistent with the literature: this was the peak period in terms of capital accumulation. The interesting thing is that the data reveal that the investment in Latin America was not outstanding in the international context. It was, in fact, in line with the one made by the countries that formed the more developed world, except the United States. Finally, developments between 1973 and 1991 show that in Latin America, as in the rest of the Western world's most industrialized countries, the new international economic environment slowed the accumulation of capital. There were similar levels of slowdown across the countries. It should be noted that the period 1973-1991 is the the most recent period for which we can currently make comparisons.

It is important to stop and consider, from a comparative perspective, the changes in the capital structure. Here, given the limitations of the data, we can only address the most basic decomposition, which distinguishes first, machinery and other equipment, and secondly, non-residential structures. It is a generally accepted assumption that technical progress has been greater in the first category of goods than in the second, which shows that the economic growth of nations depends above all on capital accumulation being concentrated in capital goods; accordingly, table 5 shows that the weight of this type of goods has increased over time in all countries.[66] Interestingly, they have tended to converge in the late twentieth century in a ratio around 35 percent of non-residential capital stock. Most industrialized countries also exhibit basic matching values for a century ago that hover around 15 percent. Table 5 arouses some doubts about the relative levels that were found in the first half of the twentieth century for countries in the sample for which only series on the second half of the century were available.

Table 5

The four Latin American countries analyzed have not been adjusted exactly to this pattern. Only Chile follows the same path as Japan. But the other three have some distinguishing trends. In the case of Argentina, it is the overwhelming dominance of infrastructure in the late nineteenth century. In Brazil, just the opposite is true: a bias towards machinery, which lasted until the mid-twentieth century. Finally, Mexico appears to be distinguished by machinery over investment during the state-led industrialization period. How has productive capital contributed to the economic growth of AL-4 across the century? Did it contribute to a greater or lesser degree than in developed countries? We are not yet able to give a clear and justified answer to these essential questions, because to do so would require us to conduct a growth accounting estimation, a task that requires mobilizing a greater volume of information than is handled here. But we can relate the series of non-residential capital of the countries in the sample with regard to GDP and the labor force, in order to gauge what level was reached, in comparative terms, for the intensity of capital in Latin America. Let us start with the capital-output ratio (see Table 6).

Table 6

The picture is puzzling. The general trend of very long term in most industrialized countries is rising, which means, of course, that the productivity of physical capital has tended

[66]The empirical reconstruction made by Ball, Morrison, and Wood, "Structures Investment" also reveals that, in a large group of OECD economies in the long term investment in equipment has grown substantially more than non-residential construction

to decline (productivity being the inverse of the ratio, ie, GDP per capital) . This inclination is not constant and uninterrupted, because in times of great increase in total factor productivity, as in the golden age, the capital-output ratio declined or stopped growing. However, there is something in table 6 that is extremely noteworthy, and that manifestly contradicts the supposed general pattern: the United States, the leading economy and the most powerful one, has followed an opposite path. It is difficult to understand, without questioning the consistency of the data, how in the early twentieth century the capital-output ratios of the two most industrialized economies could be so far apart (3.0 for the U.S., compared with 0.8 for the U.K.).[67] However, is a relevant and remarkable that all developed countries of the sample has converged on a level beyond some inevitable national singularities (the British lag and the Japanese advance). The four countries studied have, in the late twentieth century, capital-output ratios that are in line with those of the more advanced countries. Chile, and perhaps Mexico, is somewhat lower, while those of Brazil and Argentina are somewhat higher. That is, the first two levels exhibit capital productivity that is higher than the last two. This could be attributed to the very productive time of over investment during the state-led industrialization period. But this factor should not be overstated. Precisely what one would have supposed, a priori, based on literature, is that, in the 1970s and 1980s, the capital-output ratio would be, in all cases, significantly higher than in the richer western economies. Clearly, this hypothesis is contradicted by our data. The most distinctive feature of AL-4 with respect to these economies (except the U.S.) is actually a century ago. Indeed, the defining characteristic of Argentina, Brazil and Chile, but not Mexico, an economy that was barely capitalized in the early days of the Porfiriato, is that, by 1890, they were endowed with abundant productive capital relative to their economic size. In the case of the first two countries, from 1900, and for at least half century, capital intensity tended to decline. There is an interesting parallel here with the United States.

The capital intensity relative to labor may be more enlightening than the previous measure. The capital output ratio is a complex measure, especially when faced with GDP measurements with significant margins of error.[68] In any case, the amount of productive capital per worker is a determining factor in the level of labor productivity. To capture this directly Table 7 reports the amount of non residential capital per worker for each country, relative to United States.

Table 7

In the Western world, from 1890 to 1950, the United States not only held the lead in terms of capital per worker but tended to increase faster than the rest. Japan, although starting from an extremely low level, just gained an advance of 7 percentage points. Spain remained virtually stagnant, while Britain suffered a major setback. Germany, France and the Netherlands achieved some improvement, but lower in comparison with the U.S. and Japan. And what happened to the Latin American countries analysed? The first thing that stands out is their different position relative to the start point. It makes perfect sense that Mexico appears at the bottom, with a very low capital intensity in 1890, doubles that level in

[67] Maddison himself was aware of the difficulty of explaining such a difference and suggested that perhaps was due largely to errors in the estimation, but rejected the idea that there was actually no difference in capital intensity.Maddison, *Standardised Estimates*

[68] To be honest, we must recognize that the labor force measure is also fraught with difficulties. The variable that should be considered is the number of workers employed, but we simply do not have this information for the first half of the twentieth century for the majority of Latin American countries. It is not even easy to determine the population. Typically, the annual data are the result of a pure interpolation of population census records, which typically occur at ten-year intervals.

the second half of the Porfiriato, to stagnate during the Revolution, until World War II. Nor is it surprising that in 1890 Chile had a relative level similar to that of Spain, which did not experience any substantial progress in the following decades.

Another striking aspect is that the starting point of Brazil was higher than that of Spain and Chile, where the level of economic development was much lower. [69] It is equally shocking that positions were lost during the first half of the century, given the pace of economic growth, according to accepted estimates of GDP. But, compared to the initial year (1890) the figure that surely attracts most attention is that of Argentina which exceeds by far that of any other Western economy, including the UK, but excepting the U.S. at least the First World War. In order to understand this Argentinian "exceptionalism" it could be useful to make a comparison with another settler economy, like, for instance, Australia.

5.1 Australia and Argentina

One of the most intriguing phenomena in economic history is the case of Argentina, especially when it is compared with other settler economies, such as Canada, the USA, New Zealand and Australia.[70] There is a particularly long history of research into Argentina and Australia, which are seen as two "similar" countries.[71] However, the *when* and *why* of the divergence is still and open book. Regarding the *when*, Argentinian economic historians are divided between two marked dates, 1913 and 1929, which are truly turning points in its long run growth. Sanz-Villarroya concludes, using an econometric approach, that the end of the convergence was in 1899[72]. Nevertheless, this study refers only to GDP. There are reasons to continue thinking that the divergence did not begin, at least, 1913.[73] As for the cause of the divergence, there is still a wide field to explore in regard to the role played by the immediate growth factors -factor accumulation or improvements in multi-factor productivity- and ultimate factors. Far from being clear enough what prevented Argentina, first, develop potential linkages associated with the export of staples, and then substitute a type of growth based on the agro-export to another based on an efficient and internationally competitive manufacturing . It should be mentioned that recent studies on these topics, such as Altman[74] and Bértola & Willebald[75] suggest that income-wealth distribution was a key factor in determining the quality of institutions, the orientation of public policy, the dynamism of domestic demand, innovation capacity and new technology absorption, and the rate of human and physical capital accumulation. We just focus on this last point, which illuminates the dynamics of a number of aspects that are not exclusively supply factors (entrepreneurship, intensity of incorporation of technical change, scale of public investment, etc..).

[69] Here we find another sign that accepted estimates of GDP (and GDP per capita) in Brazil in the late nineteenth century are probably a downward bias.

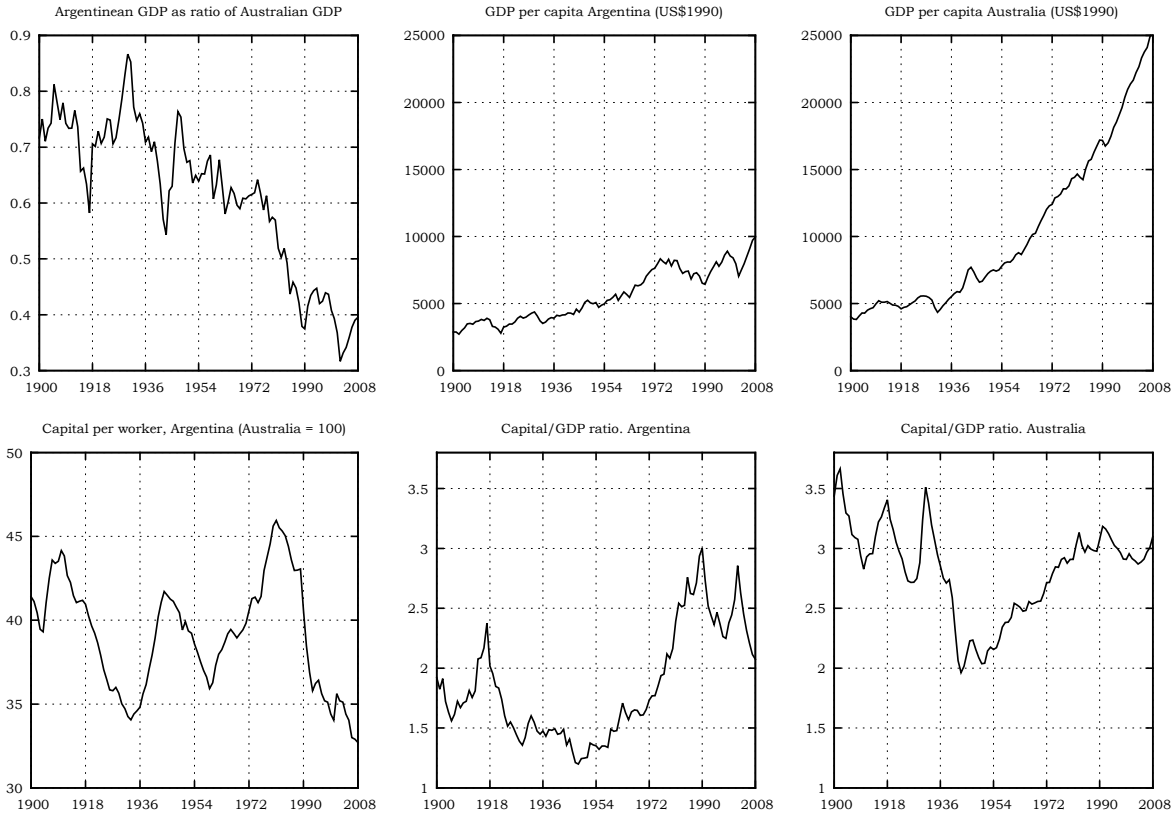
[70] About settlers economies v. Lloyd, Metzer, and Sutch, *Settler Economies*. Another country analysed in this work -Chile- is for Denoon, *Settler capitalism*, p.60 a settler society *border* case, because of the importance and influence of its aboriginal inhabitants; the vast majority of researchers had considered the same criteria. Argentina appears, however, as the Latin American settler economy *par excellence* and the most important (although not the only one).

[71] Mclean, "Australian" cites the works than have addressed the issue, although not exhaustive, perhaps because the author's main interest is to elucidate the driving forces of Australian economic performance over time. From the Argentinian perspective, the literature review conducted by Korol, "Argentine Development" is useful, although his balance is disappointing , because he denies the explanatory power of the comparative approach in revealing the keys to Argentina's economic failure.

[72] Sanz-Villarroya, "The convergence" quoted the articles dealing with this issue.

[73] McLean gave an answer as to why 1895 - 1913 was the only one period when there was international economy prosperity (or expansion) with a backwardness of the Australian economy. He takes as example and contrafactual

Figure 2: GDP per capita, Capital per worker and Capital output ratio.
Argentina and Australia. 1900 - 2008



Sources: GDP per capita Maddison Project; Capital Stock in Australia estimated based on Butlin and Haig and Capital Stock in Argentina, see Data at
https://sites.google.com/site/cristianaducoingruiz/non-residential-capital-stock-in-latin-america-series

The starting point of this comparison must take into account the GDP per capita of Argentina in relation to Australia. The evolution was as follows (Australia = 100): in 1890, 54.7, 1913, 73.6, 1929, 83.0, 1950, 67.3, 1973, 61.8, and in 2010, 40.1.[76] As our contribution consists in the capital accumulation history in both economies, we are looking to compare performances to see if the observed divergence in GDP may be associated with different patterns of investment in equipment and non-residential construction. So we have had to calculate the non-residential capital stock of Australia by as similar a procedure as possible to the steps we have followed for Argentina. We have built on the series of GFCF in equipment and non-residential construction for the period 1861-1939 derived from detailed reconstruction

the Argentinian economy. McLean, "Recovery From Depression"
[74]Altman, "Staple theory".
[75]Willebald and Bértola, "Uneven Development".
[76]Bolt and Zanden, *The First Update*.

made by Butlin.[77] The resulting figures have been linked with those offered by Kamps[78][79], the Historical National Accounts of Australia and Australian Bureau of Statistics[80]. The main results of our comparison are condensed in Figure 2 and Tables 8 and 9.

table 8

So back to the question we posed at the beginning of this comparison: can the divergence between Argentina and Australia be explained by physical capital accumulation? At first glance, the figures in Table 8 only allow us to give an ambiguous answer. In the very long run, the capital increased more in Australia than in Argentina, but the difference is not significant. However, if one looks deeper, this differential is reduced mainly due to the fact that the capitalization of Argentina advanced with much more force than Australia during the period of the *Belle Époque*(1900-1913 in the table). There was another period, (1930-1945), in which Argentina had a better performance than Australia, but in the rest of the century after 1913 Argentina was unable to extend the stock at the same rate as Australia did. This empirical evidence confirms the view taken by Willebald[81] that the divergence between the settlers of the South American countries (Argentina and Uruguay) and the North American ones (Canada and USA) and Australasia (Australia and New Zealand) was deep and persistent after World War II, which the author attributed to the inability of Argentina and Uruguay to develop a pattern of effective specialization to replace the traditional agro-export model.

Table 9 contains new clues that shed light on the uneven performance of the two economies analyzed here, while some of the figures in this table are unexpected and perhaps raise new questions that further research should clarify. One of the highlights is that the abnormally low ratio of capital equipment in total distinguishes Argentina during the first half of the twentieth century. Tables 5 and 6 show that this is an extreme case of over-investment in

[77] Butlin, *Australian domestic* offers complete data about private and public investment at constant prices (table 270A, pp. 462-3, and 270B, pp. 464-5).For both investment series he gave annual series with the spending for several sectors In the case of private investment these sectors are: residential, industrial, commercial, mining, shipping, pastoral and agricultural. In the case of public investment the sectors covered are: housing, water and severage, public buildings roads, bridges, railways, telegraph, electricity, agriculture, defence, other industrial undertakings, local and semi-government authorities, miscellaneous. Our estimation consisted in calculating the spending in GFCF on equipment and GFCF on non-residential construction, separately. Also, we have use the data from Barnard and Butlin, "Australian Public" and Haig, "New Estimates". Where we did not have direct evidence for Australia, we have supposed that the relative weights applied by Feinstein, *Studies in capital formation* for UK are valid for Australia. The estimation has been made as follows: in relation to private non-residential construction (commercial), we have applied growing ten-year ratios on equipment investment taken by Feinstein, *Studies in capital formation*, P. 309. With respect to manufacturing, for the period 1861 - 1900, we have applied, as fixed coefficient, the average share of equipment investment (69,8%) and structures (30,2%). This estimation is the result of the values given by Butlin, *Australian domestic*, table 205, p.340 for the period 1901 - 39. The shares' variance in 1901 - 39 is very low, and hereafter, it is a reasonable assumption to set a fixed coefficient. In the case of mining we have applied the same share as in manufacturing. Referring to shipping, following Feinstein, *Studies in capital formation*, p.334, we have supposed that all the investment is in equipment. Finally, to ascertain the value of pastoral and agricultural equipment, we have followed the same procedure as for manufacturing. Referring to public investment, the estimation is less certain. In the case of water and severage, roads and bridges, we have calculated structures as a whole. In the case of telegraph and electricity, following Feinstein, *Studies in capital formation*, p.305, we have assigned 85% as equipment investment. Regarding railways, and taking into account the research by Mitchell, "The Coming", two periods have been considered: for the period 1861 - 90, we have established the equipment investment share as 23,5% and 76,5% for the rest (structures). In the period after 1890 the shares will be 34,9 and 65,1, respectively. Finally, decomposition of "other industrial undertakings", "local authorities and semi government authorities" and "miscellaneous" has been realized by applying the relative weights resulting from the previous items' aggregation.

[78] Kamps, *New Estimates*.

[79] https://www.ifw-kiel.de/forschung/datenbanken/netcap

[80] History of Australian National Accounts Consulted 28th April

[81] Willebald, "Desigualdad".

structures at the cost of underinvestment in equipment . The contrast with Australia is huge. This may be due to the very rich mineral resources endowment, which created strong linkages and incentives to invest in machinery equipment, which were absent in Argentina. The ratio differential is enormous between both countries, probably this fact is also related with the earlier development of Australia's manufacturing industry.

Another striking aspect of Table 9 is the extremely different trajectory and level of capital-output ratio (Figure 2 shows this feature even more clearly). The Australian economy was in 1900, much more capitalized than Argentina and this fact has continued to the present, although differences were decreasing in the last decades of the twentieth century. Australia is similar, in this sense, to the U.S. economy and is clearly distinguishable from the non-settler economies. This suggests that settler economies are most dynamic in the early stages of their development, endowed with a huge amount of capital in relation to the volume of their economic activity, which no doubt enabled them to further increase their productive capacities. Argentina followed another path, because the public sector lacked the investor activism that characterized Australia, before and after the formation of the Federation, and also because private investment in Argentina was strongly influenced by an agricultural development model based on *extensive land ownership*. As new terrain was cultivated in the *Pampa* and the border was displaced and at the same time the rail lines were extended, GDP and GDP per capita grew very rapidly without too much capital (other than that used in the railroad itself). In fact, the capital became very productive in Argentina.[82] A final measure, capital per worker, shows a very revealing comparison: in Argentina capital per worker has always been well below that of Australia (see Table 9). In this area there has not been any case of convergence (Fig. 2). It is easy to deduce that the delay in capital deepening in Argentina is related with the increasing divergence between the two economies analyzed in this section. It is interesting to note that the gap was increased after 1913.

Concluding this section, we can affirm that the new evidence reinforces ideas defended by several specialists. The year 1913 was a real turning point in the long-term growth of Argentina's economy and, also in its capitalization process. It is a perfectly plausible hypothesis that this situation arose because until then Argentinian capital formation was financed to an unusually high degree by foreign capital.[83] Following the outbreak of World War I, the inflow of foreign capital was greatly reduced, and Argentina did not have the ability to supply it with domestic savings. This may have been due to its high rate of dependence[84], or the underdevelopment of its financial system.[85] Within a few decades , when investment capacity could be less influenced by these factors, the inward - looking economic strategy resulted in a large increase in the relative prices of capital goods which became a serious obstacle to productive investment.[86]

6 Final Thoughts

Given the quantitative and qualitative characteristics of Latin American economic growth there have been several hypotheses to explain the sharp divergence that has occurred in

[82]Davis and Gallman, *Evolving Financial*, p . 695. These authors have calculated the capital-output ratio in both countries. His figures are different from ours because they include livestock in the results Davis and Gallman, *Evolving Financial*, p. 696 and 749-52.

[83]Taylor, "Tres fases".

[84]Taylor, "External Dependence".

[85]Davis and Gallman, *Evolving Financial*, p . 712-23.

[86]Hayn, "Capital formation"; Díaz Alejandro, "Essays on the Economic History".

the long twentieth century in relation to the developed world. In recent years, quantitative investigations have become increasingly important in moving specialists with the need to know *when*, as well as *how* the Latin American relative backwardness begun. With the results we have collected around the capital stock and taking into account indicators such as the capital-output ratio (Because is an indicator of further deepening of productive investment) and capital per worker (as a measure of capital-intensity per work unit), one can say the following. Firstly, Latin American economies were very dynamic, absolute and relative, in the heyday of the first globalization (before 1914). Its capital production expanded very rapidly, both in terms of GDP and population. Secondly, World War I broke this dynamic, because, in the new context created by the conflict and the post-war scenario the old model of export-led growth lost steam and capacity. Thirdly, the Great Depression and World War II gave new impetus to capitalization, in an stagnated environment in the developed world. But this opening stage of import substitution industrialization (ISI) was far from being as bright as that experienced in the first globalization era. Fourthly, the Latin American economy diverges from the advanced economies in the state - led industrialization period subsequent to World War II. The difference is especially marked if we consider the situation during these years in Argentina and Chile. Brazil remains at the same distance of the leaders of the developed world and Mexico is the only one that reduced the distance to them. This finding contradicts the view held in recent studies, such as Bértola & Ocampo[87], who value more positively the fruits of ISI in Latin America. The point of agreement we find with these authors, is that economic performance brought about by the intensification and deepening of the capital, had a positive impact on the economies with larger domestic markets such as Brazil and Mexico, while the process of capital accumulation during the long twentieth century deteriorated and slowed down in the economies of Argentina and Chile. The rather disappointing behavior of these countries, in light of the indicators presented in this paper, was determined especially by the difficulty of replacing lost markets after the Great Depression in the case of Chile and World War II in the case of Argentina. Finally, the comparison between Argentina and Australia, opens new questions about the relative position of Argentina in the world economy, especially if we compare the capital per worker at the beginning of the twentieth century. There was a gap favourably to Australia bigger than the GDP per capita measures, illustrating initial differences bigger than the previous estimates.

[87] Bértola and Ocampo, *The Economic Development*.

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7 Tables

Table 1: Life expected of the assets. Several authors' estimations (in years) and depreciation method.

Country / Author	Non Residential Construction	Machinery and Equipment	Depreciation
Argentina:			
Hofman, *The Economic development*[1]	40	15	Straigth
Balboa and Fracchia, "Fixed Reproducible"	50	20	Straigth
Maia and Nicholson, *El Stock de capital*	50	15	Straigth
Goldberg and Ianchilovici, "El stock de capital"	70	20	Straigth
Brazil:			
Marquetti, "Estimativa do estoque"	50	14	Geometric
Morandi and Reis, "Estoque de capital"	40	20	Geometric
Feu et al. (2007-8)	40	20	?
Chile:			
Haindl and Fuentes, "Estimación del stock"	60	15	Straigth
Henríquez, *Stock de Capital*	100 - 50	18-nov	Straigth and Geometric
Mexico:			
Mariña, "Formación y acervos"	58	15	Straigth
AL-4:			
This work, 1850-1920	50	25	Straigth and Geometric
This work, 1921-1975	40	20	id.
This work, 1976-2008	40	15	Id.
	1 The same criteria for Argentina, Brazil, Chile and Mexico.		

Table 2: Growth rates of Non residential capital stock

	Argentina	**Brazil**	**Chile**	**Mexico**
Periods				**Gross Stock**
1900-2008	3.4	4.3	3.2	5.2
1900-1929	3.6	3.6	3.6	3.8
1930-1945	2.5	2.2	1.5	3.2
1946-1981	5.1	6.3	3.9	7.4
1982-2008	1.7	2.5	6.2	3.5
	Net Stock (Straigth depreciation)			
1900-2008	3.3	4.4	3.3	5.2
1900-1929	2.7	3.4	3.3	2.8
1930-1945	1.9	1.7	0.5	3.6
1946-1981	5.1	6.6	3.7	7.2
1982-2008	1.1	2.0	6.8	3.1
	Net Stock (Mixed Depreciation)			
1900-2008	3.1	4.6	3.3	5.1
1900-1929	2.5	3.1	2.8	2.4
1930-1945	1.7	1.7	0.4	3.8
1946-1981	4.9	7.1	3.7	6.7
1982-2008	1.0	2.3	7.1	3.3

Table 3: Machinery and Equipment Capital Stock. Growth rates.

	Argentina	**Brazil**	**Chile**	**Mexico**
Periods				**Gross Stock**
1875-2008	6.2	4.1	4.0	6.2
1875-1890	16.6	7.6	4.4	10.9
1891-1913	9.9	5.7	8.5	9.5
1914-1929	3.5	2.6	2.8	2.8
1930-1945	4.5	1.8	0.5	3.6
1946-1981	7.0	5.7	4.3	9.2
1982-2008	2.0	0.8	7.5	3.4
	Net Stock (geometric depreciation)			
1875-2008	5.9	3.9	4.0	6.1
1875-1890	21.4	8.1	4.5	11.8
1891-1913	10.2	4.1	8.2	9.1
1914-1929	4.1	2.3	3.8	5.9
1930-1945	1.1	-0.6	-4.5	3.2
1946-1981	7.0	6.4	3.7	8.8
1982-2008	2.1	2.1	9.6	4.6

Table 4: Non Residential Capital Stock growth rates.

	1890-1991	*1890-1913*	*1913-1929*	*1929-1950*	*1950-1973*	*1973-1991*
UK	2.5	2	1.2	0.9	5.5	3.1
USA	2.7	4.4	2.7	1.2	3.2	3.2
Japan	5.6	3.4	5.7	3.5	9.8	6.5
Germany				-1.1	6.9	3.3
France					4.9	4.2
Netherlands					4.8	2.8
Spain	3.8	2	2.7	1.5	6.4	5.6
Argentina	3.4	4.5	0.7	2.2	5.3	3.4
Brazil	4.2	3.4	1	2.4	5.7	6.1
Chile	3	3.8	1.4	1.3	4.6	2.8
Mexico	5.2	7	1.8	4.2	7.4	5.1

1 1938 - 1950

Table 5: Gross Capital Stock ratio in machinery in relation to Non Residential Gross Capital Stock.

	1890	*1900*	*1913*	*1929*	*1939*	*1950*	*1973*	*1991*
UK	0.15	0.13	0.16	0.18	0.15	0.26	0.31	0.35
USA	0.14	0.16	0.22	0.3	0.34	0.38	0.39	0.36
Japan	0.14	0.22	0.28	0.38	0.35	0.42	0.33	0.35
Germany						0.13	0.32	0.33
France					0.17	0.22	0.32	0.31
Netherlands						0.13	0.31	0.34
Spain	0.16	0.14	0.18	0.24	0.27	0.21	0.36	0.35
Argentina	0.04	0.05	0.1	0.12	0.17	0.22	0.34	0.37
Brazil	0.35	0.49	0.57	0.59	0.58	0.54	0.44	0.33
Chile	0.13	0.21	0.38	0.38	0.35	0.3	0.33	0.32
Mexico	0.19	0.22	0.28	0.27	0.28	0.36	0.56	0.43

Table 6: Capital ratio (non residential) / GDP

	1890	*1900*	*1913*	*1929*	*1950*	*1973*	*1991*
UK	0.8	0.8	0.8	0.9	0.8	1.3	1.7
USA	3	3	3.3	3.2	2.4	2.1	2.3
Japan	0.7	0.7	0.9	1.1	1.7	1.7	2.8
Germany					1.6	1.5	2.2
France					1.5	1.7	2.2
Netherlands					2	1.9	2.2
Spain	0.8	0.8	0.9	1	1.5	1.5	2.3
Argentina	2.1	1.9	1.7	1.1	1.1	1.6	2.5
Brazil	2.3	3.8	3.8	2.6	1.9	1.7	2.6
Chile	1.3	1.6	1.8	1.7	1.7	2	1.9
Mexico	0.5	0.7	1	1.2	1.3	1.7	2.1

Table 7: Capital stock per worker; comparative with USA

	1890	*1900*	*1913*	*1929*	*1939*	*1950*	*1973*	*1991*
UK	100	100	100	100	100	100	100	100
USA	31.8	28.8	22.6	19.8	22.2	22.2	42.7	54.2
Japan	5.3	5.5	5.5	8.9	12.4	13.9	48.3	104.4
Germany						32.5	57.9	89.9
France						30.8	71.3	93.9
Netherlands						52.6	78.6	82
Spain	13.3	12.4	12.3	13.6	17.1	15.8	35.8	72.5
Argentina	52.8	45.3	40	25.6	30.2	25.8	42.1	46.9
Brazil	18.5	21.2	20.5	15.1	15.8	15.8	21.5	28.9
Chile	13.6	14.9	17	16	15.8	15.6	20.8	17.9
Mexico	4.9	7.9	11.6	12.3	14.6	18.8	33.9	35.7

Table 8: Annual compound growth in capital stock, Argentina and Australia

	Argentina			**Australia**		
	Machinery	Non residential construction	Total	Machinery	Non residential construction	Total
1900-2008	5.5	2.5	3.0	4.0	3.4	3.3
1900-1913	15.1	5.0	5.5	4.7	3.1	2.8
1914-1929	3.3	0.5	0.7	2.6	2.8	1.6
1930-1945	-1.0	1.5	1.3	-0.7	1.1	0.7
1946-1981	6.6	3.0	3.6	5.5	3.6	3.9
1982-2008	4.5	2.2	2.9	4.8	5.2	5.2

Table 9: Ratio Machinery - Non Residential, Capital Ratio and Capital per Worker (Australia = 100).

	Argentina			**Australia**		
	Machinery/ Non Residential	Capital output ratio	Capital per worker (Australia = 100)	Machinery/ Non Residential	Capital output ratio	Capital per worker
1900	0.05	1.9	41.4	0.38	3.4	100
1913	0.10	1.7	42.3	0.47	3	100
1929	0.12	1.1	35.7	0.48	2.9	100
1939	0.17		37.1	0.39	2.7	100
1950	0.22	1.1	39.4	0.50	2.5	100
1973	0.34	1.6	41.3	0.72	2.7	100
1991	0.37	2.5	38.5	0.63	3.2	100
2008	0.52		32.7	0.65	3.1	100